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Abscess Disease in Pastoral and Feedlot Sheep in The Sudan

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ABSTRACT

Morel's disease caused by *Staphylococcus aureus* subsp. *anaerobius* and caseous lymphadenitis caused by *Corynebacterium pseudotuberculosis* are important diseases of sheep in the Sudan. Both diseases cause significant economic losses due to rejection of affected animals at veterinary quarantines and condemnation of carcasses of sheep in abattoirs. Surveys were conducted for abscesses in 2000 pastoral sheep, 2100 breeder sheep, 8600 sheep kept for fattening, and 12694 sheep in other collection areas including sheep markets, export quarantine and its vicinity. Mean morbidity was 16.7%, with significantly higher morbidity ($p<0.0005$) sheep kept for fattening compared to unfattened (breeder and pastoral) sheep. A strong association (Phi Coefficient = 0.278) was found between the fattening of sheep and the incidence of abscesses. Two local sheep ecotypes (Hamari and Kabbashi) were susceptible to the disease with mean incidence of 50% and 33.9%, respectively. Other local sheep ecotypes (Wateesh, Dubasi, Zaghawi and Baladi) had low incidence of abscesses (0.7, 1.9, 4.8 and 8.8%, respectively). Bacteria isolated from affected lymph nodes of sheep with clinical abscesses (N=217) were 65.95% for *S. aureus anaerobius*, 19.8% for *C. pseudotuberculosis*, 5.1% mixture of both bacteria and 6.5% for other staphylococci. The results of this investigation expand on the existing knowledge on Morel's disease and are useful in the design of control programmes of the disease in the Sudan.

INTRODUCTION

Morel's disease (MD) and caseous lymphadenitis (or pseudotuberculosis) are diseases of sheep manifested by the formation of abscesses in the subcutis or in superficial lymph nodes (Musa *et al*., 2012b). Morel's disease is (also known as sheep abscess disease) caused by *Staphylococcus aureus* subsp. *anaerobius* (de la Fuente *et al*., 1985, Elbir, 2010, Musa *et al*., 2010, 2012b), that usually affects lambs at ages between 4-10 months, especially those under fattening (Babiker and El Sanousi, 1998, 2004). Caseous lymphadenitis (CLA) is caused by *Corynebacterium pseudotuberculosis* (Dorella *et al*., 2006, Kumar *et al*., 2013) and is usually encountered in sheep of older ages. Abscesses of sheep cause great economic losses due to either rejection of live sheep at veterinary quarantines, or condemnation of sheep carcasses during meat inspection in slaughter houses (Musa *et al*., 2012a, b). Economic losses amounted to several millions of US dollars due to rejection of shipments destinated to Saudi Arabia because of Morel's disease (Babiker, 2001, Aklilu, 2002, Musa, 2012, Musa *et al*., 2012b). Both MD and CLA have been reported previously in the Sudan (El Sanousi *et al*., 1989, Hamad *et al*., 1992, Musa *et al*., 2007), but the prevalence of each disease was not studied. The aim of the present investigation was to study the prevalence of sheep abscess disease in Sudan in order to appreciate the magnitude of the problem.

MATERIALS AND METHODS

Survey

Surveys for abscesses were conducted among sheep in different management systems in the Butana, Elbagair (North Gezira), Omdurman and Khartoum North, Sudan. The surveys included sheep grazing in natural pasture (N=2000), breeder sheep (N=2100), sheep kept for fattening in 2 feedlots (N=8000) and one backyard system (N=600), in addition to sheep in two livestock markets, sheep in the export veterinary quarantine and its vicinity (Table 1). Presence of abscesses in the animal body was determined by visual examination and palpation of superficial lymph nodes at the head, shoulder and precrural regions. Data including the morbidity rate, sheep ecotype, source areas, distribution of abscesses in the animal body and the system of husbandry were collected.

Fattened sheep follow up

A flock of sheep consisting of Hamari (N=1765) and Zaghawi (N=4400) ecotypes were followed up during a period of fattening of 20 days until being brought to the export quarantine in Khartoum North. The animals were examined for the presence of clinical abscesses or enlarged superficial lymph nodes. The animals were then screened every five days for the appearance of abscesses.

Collection of samples

Pus samples were collected from ripened abscesses of live animals (N=217) as follows: the hair over the area of the abscess was clipped, disinfected with 70% alcohol, and a small incision at the bottom of the abscess was made. The abscess was squeezed by forceps into a sterile screw-capped bottle and transferred into thermo-flasks to the lab for bacteriological examination. For comparison, enlarged superficial lymph nodes (N=184) were collected from sheep slaughtered for local consumption at Omdurman abattoir.

Identification of bacteria

Direct smears were made from 120 pus samples (108 from sheep abscesses at different collection areas and 12 from enlarged lymph nodes of slaughtered sheep) and stained with Gram's satin according to Barrow and Feltham (1993). Culture of pus

samples and identification of isolated bacteria were done as described by Musa (2012) and Musa *et al*. (2012b).

Statistical analysis

Data collected during the survey were entered in Excel sheets and then analyzed by the Statistical Package for the Social Sciences (SPSS 17.0). Chi-Square (χ^2) test was used to examine the effect of the management system of sheep on the incidence of abscesses; mainly considering the feeding: fattening (in feedlot and backyard sheep) and natural or non-fattening (in pastoral and breeder sheep). The *Phi Co-efficient* was used to measure the degree of association between incidence of abscesses and fattening of sheep.

RESULTS

Survey

Clinical abscesses were encountered in 4238 out of 25394 examined sheep in different collection areas giving an overall prevalence of 16.7% (Table 1). A morbidity rate of up to 36.7% was recorded in feedlot sheep, while in breeder and pastoral sheep it was 5.7 and 5.8%, respectively (Table 1).

Table 1: Prevalence of abscess diseases in sheep at different collection areas

Location	Number examined	Number affected	%	Feeding
Albagair_(feedlot)	5000	1480	29.6	1*
Alfataleeb (feedlot)	3000	1100	36.7	1*
Alsamrab (feedlot)	600	50	8.3	1*
Albagair (breeder)	2100	120	5.7	2*
Butana (pastoral sheep)	2000	115	5.8	2*
Alkadaro town	7000	1100	15.7	.
Abuzaid (livestock market)	327	69	21.1	.
Alkadaro quarantine	4167	142	3.4	.
Alhafaya (livestock market)	1200	62	5.2	.
Total	25394	4238	16.7	

Feeding: 1 = fattening, 2 = natural/non- fattening, (.) = non specific or maintenance. **Pearson's Chi-Square* test value <0.0005, *Phi Coefficient* = 0.278 with significance <0.0005 (between group1&2).

Pearson's Chi-Square test value was <0.0005 (very high significance) for the incidence of abscesses among fattened sheep (in the backyard and feedlot systems) in comparison with the incidence among unfattened (breeder and pastoral) sheep. *Phi* correlation coefficient value was 0.278 (with significance at <0.0005) for the association between fattening and incidence of abscesses in sheep.

A mean of 48% of the abscesses in the surveyed animals were in the parotid, 43.7% in the prescapular, 4.6% in the submanidular and 3.8% in other parts of the body (Figure 1 and Table 2). In pastoral sheep, 25% of the affected prescapular lymph nodes were unilateral and the rest (75%) were bilateral, while the parotid lymph nodes 71.4% were in the left side and 28.6% in the right side. In feedlot sheep with abscesses in the parotid lymph node 45.2% were in the left side, 25.6% in the right side and 29.2% were bilateral abscesses. The consistency of the pus expressed from the lymph nodes varied from watery to pasty and sometimes it was caseated, while its colour was greenish yellow to yellowish white. The abscesses ranged between 5 and 10 cm in diameter, whereas larger abscess (>15 cm) were sometimes encountered.

Figure 1: Abscesses in the different parts of the body of sheep

Table 2: Superficial lymph nodes affected with abscesses in sheep

Location	No. of affected animals	Affected lymph nodes (%) Prescapular	Parotid	Submandibular	Other
Alkadaro quarantine	131	42.7	40.5	6.9	9.9
Alkadaro town	1100	36.4	54.5	0.0	9.1
Abuzaid (livestock market)	69	78.3	18.8	2.9	0.0
Butana (Pastoral sheep)	115	50.4	38.3	12.2	0
Alfataleeb (fattened sheep)	1150	10.8	87.7	1.1	0
Total	2565	43.7	48.0	4.6	3.8

Most of the affected sheep were in good to excellent body condition, whereas unaffected animals were relatively in poor body condition. The two mostly affected sheep ectoypes were the Hamari and Kabbshi (Table 3).

Table 3: Incidence of abscess diseases in Sudanese sheep ecotypes (%)

Location	No. of affected animals	Hamari	Kabbashi	Zaghawi	Dubasi	Wateesh	Baladi
Abuzaid (livestock market)	69	49.3	43.5	1.4	5.8	0	0
Alkadaro	1300	50.0	35.4	2.3	1.5	0.8	10
Different locations	108	50.0	9.3	37.0	3.7	0.0	0.0
Total	1477	50.0	33.9	4.8	1.9	0.7	8.8

Fattened sheep follow up

Appearance of abscesses in fattened sheep increased gradually during the fattening period (Figure 2). Out of the 1765 Hamari sheep 1100 (62.5%) developed abscesses, while only 50 out of the 4400 (2.5%) Zaghawi sheep developed abscesses during the whole period of follow up.

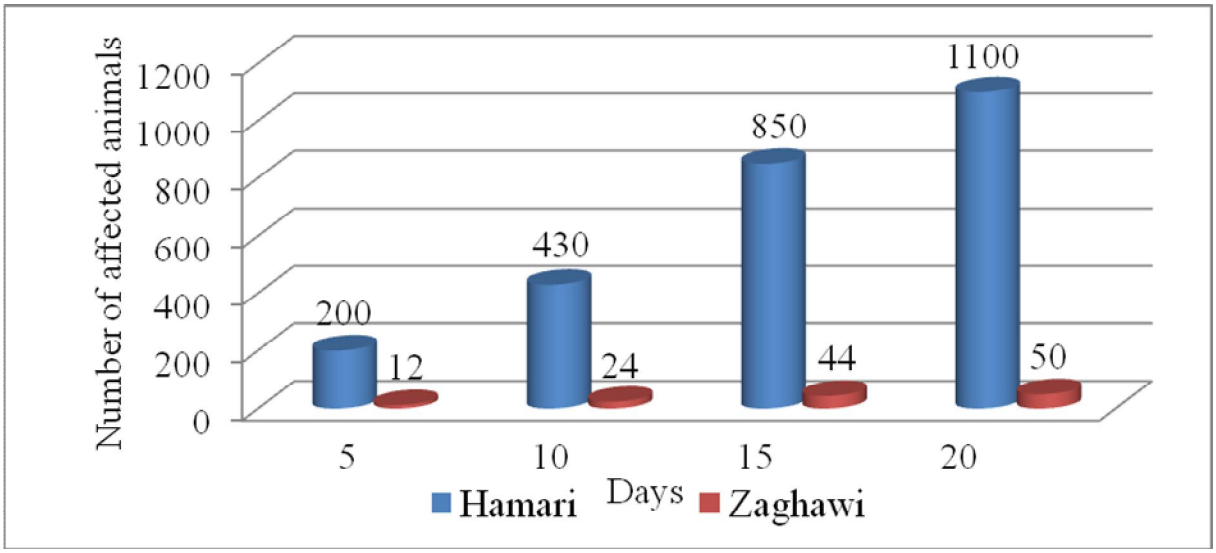

Figure 2: The percentage of different breeds of sheep affected by abscess

Bacterial isolates

Direct smears made from 120 pus samples showed Gram positive (G+ve) organisms in 70 samples (58.3%), whereas in the rest 50 samples no organisms were seen in the smears. Out of the 70 positive smears, 57 (81.4%) showed G+ve cocci, whereas 10 (14.3%) showed G+ve coccobacilli, 3 (4.3%) showed both G+ve cocci and coccobacilli.

Bacteria isolated from affected lymph nodes of sheep with clinical abscesses were mostly *Staphylococcus aureus anaerobius* (65.95%), *Corynebacterium* spp. (19.8%), other staphylococci including *S. aureus* subsp. *aureus* (6.4%) and mixture of *S. aureus anaerobius* and *Corynebacterium* spp. (5.1%), while the rest (2.8%) yielded no growth (Table 4). In slaughtered sheep the most prevalent bacteria was *Corynebacterium* spp. (47.3%), while the prevalence of *S. aureus anaerobius* was 42.4% (Table 4).

Table 4: Bacteria isolated from sheep with clinical and subclinical cases of abscesses (%)

	Live sheep		Slaughtered sheep	
Bacteria	Number	%	Number	%
S. aureus anaerobius	143	65.9	78	42.4
Other staphylococci	14	6.5	19	10.3
Corynebacterium spp.	43	19.8	87	47.3
Mixed growth	11	5.1	0	0
No growth	6	2.8	0	0

DISCUSSION

Morel's disease and pseudotuberculosis are important sheep bacterial diseases that cause significant economic losses, especially in export sheep in the Sudan. Based on visual examination, sheep with clinical abscesses are rejected at veterinary quarantines and at ante-mortem examination in slaughter houses, while carcasses of sheep with sub-clinical abscesses are partially or totally condemned at meat inspection in the slaughterhouses. Abscess formation is commonly encountered in all sheep, but this problem was observed frequently in sheep

kept for fattening under feedlot conditions (Aynaud, 1927). In the Sudan, sheep management falls under one of three systems, namely, the pastoral, the semi-closed or backyard system and the feedlot system. Feedlots receive unfinished lambs from pastoralist breeders through middle men in primary markets. In the present study, over twenty five thousand sheep at different collection areas were surveyed for the prevalence of abscesses. In pastoral system, where lambs are allowed to graze naturally, the incidence of abscesses was apparently low because lambs graze in open pastures without the stress of crowding or confinement. In the semi-closed system, where lambs are offered concentrate rations and left to graze part of the day on green feed such as Sudan grass or irrigated pasture, a prevalence rate of 8% was encountered. In the feedlot system a higher prevalence rate of 36.7% was encountered, which illustrates the association of the disease with fattening conditions. This was confirmed by the *Pearson's Chi-square* ($\chi 2$) test value of <0.0005, which means that incidence of the abscesses in sheep was affected by fattening with confidence probability of 99.95%. The *Phi Coefficient* value of 0.278 with very high significance (< 0.0005), lying in the interval of 0.25-0.30, which corresponds to a "*Moderately Strong*" level of association, confirms the association between the fattening and the abscess disease of sheep. The high morbidity rate in feedlot sheep also illustrates the contagious nature of the sheep abscess disease. Animals kept under such systems are usually confined and are more liable to exposure than animals on open pasture. Furthermore, the risk of contamination of the animals' feed and water and their surroundings with pus from ruptured abscesses is high, thus increasing chances of infection.

Although all Sudanese sheep ecotypes seem to be affected by abscesses (mainly Morel's disease), it is clearly that the Hamari and Kabbashi are highly susceptible, while other ecotypes are relatively resistant to the disease. Although the distribution of each ecotype in the examined flocks was not clear, the observations made on the flock followed up during the fattening period showed the relatively higher degree of resistance to infection by the Zaghawi sheep as reflected by the low incidence rate of abscesses (2.5%) compared with the 62.5% incidence rate in the Hamari sheep under the same management conditions. The low prevalence rate of abscess disease encountered in some collection areas did not reflect the actual prevalence rate of the disease. This is due to the continuous culling of affected animals from these flocks. However, data from these areas is more useful for appreciation of the ecotype distribution of the disease. The high general morbidity rate (16.7%) indicates the rapid spread of the disease and its contagious nature (Alhendi *et al*., 1993).

The rejection of several shipments of exported live lambs after docking in import terminals has been a frequent cause of embarrassing economic losses and constraint to animal exports from the Sudan (Babiker, 1996, Rodwan, 1996, Aklilu, 2002, Freigoun, *et al*., 2009, Musa, 2012, Musa *et al*., 2012b). Such lambs most probably acquire infection during the brief period of pre-shipment fattening. The contagious nature of Morel's disease under such circumstances is also aided by the obvious overcrowding during feedlotting and transportation. Abscesses involved mostly the lymph nodes in the head, the neck and the shoulder regions. Such a mode of infection suggests small abrasions and self-inflicted injuries or wounds caused by sharp ends of metallic feeding troughs as port of entry (Alhendi *et al*., 1993). Earlier

observations on the disease described more or less similar distribution of lesions. Morel, who was the first to report the disease in 1911, found the pre-scapular, popliteal, inguinal, and parotid lymph modes to be the most commonly affected lymph nodes. Aynaud (1927) and Joubert (1958) considered the angle of the jaw, the shoulder and the scrotum to be the predilection sites of abscess formation in feedlot sheep. Alhendi *et al*. (1993) found the disease to affect mainly the lymph nodes of the head, neck and shoulder. These differences in involvement of lymph nodes can be attributed to the site of the wounds or abrasions that served as portal to infection (wounds during sheering in Europe and feeding troughs in Sudan and Saudi Arabia). In this study, abscesses were found mostly to affect parotid, pre-scapular lymph nodes, with difference in the order of affected ones between feedlot and free grazing sheep. However, it is difficult to determine which one is the most involved, as the occurrence of abscesses varies from one flock to another.

As Morel's disease and caseous lymphadenitis share a similar picture, differential diagnosis is mainly based on bacteriological examination of the pus material (Musa *et al*., 2012b). Therefore, it is important to know the prevalence of each disease in order to develop vaccine(s) and to design vaccination strategies against sheep abscesses. Bacterial culture of pus samples obtained from surveys for abscesses in free grazing sheep, feedlot sheep, and other sheep collection areas showed *S. aureus* subsp. *anaerobius* as the most prevalent bacteria. Isolation of this bacteria in high percentage (66%) from sheep abscesses illustrates the significance of this organism in their aetiology. Bajomcy *et al*., (1984) highlighted the importance of *S. aureus* subsp. *anaerobius* and to a lesser extent *Corynebacterium pseudotuberculosis* in the aetiology of abscesses in sheep and noted the contagious nature of the two infections. The same observation was made by Musa *et al*., (2012b) in sub-clinical abscesses of sheep intended for export. Other staphylococci were also isolated in this study, but their role in abscess formation is not known and has not been investigated. Some other staphylococci, as well as other bacteria were also isolated from clinical and sub-clinical cases of abscess disease (Al-Harbi, 2011, Musa 2012, Musa *et al*., 2012b). However, Musa (2012) found that *S. aureus* was also able to cause clinical abscesses in experimental infection of sheep. The high percentage of isolation of *Corynebacterium* spp. from pus samples obtained from Omdurman central abattoir could be explained by the chronicity of these infections as sheep slaughtered for local consumption are not usually fattened and are slaughtered at relatively older ages than those exported. These sheep also show moderately sized indurated lymph nodes from which other bacteria can be isolated. It is noteworthy that some abscesses can contain both causes of abscesses in sheep (*C. psuedotuberculosis* and *S. aureus anaerobius*). Musa *et al*., (2012b) reported the same finding in subclinical abscesses. However, the primary cause of the abscess was not clear.

In conclusion, results of this study highlight the importance of Morel's disease in sheep of the Sudan, especially those intended for export, and the importance of development of vaccine and vaccination protocols against it. Furthermore, the apparent resistance to infection observed in many sheep ecotypes of the Sudan, as reflected by the low incidence of the disease, would be of value in future breeding programmes for the improvement of the health of the national flock and for selection of suitable breeds for export.

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Legends to the figures:

Legend to Figure 1

Involvement of different lymph nodes in sheep affected with natural infection with abscess disease

A: involvement of the popliteal lymph node. Note sloughing of the hair and redness indicate ripening of the abscess. The dark red colour in the centre indicates natural opening of the abscess and discharge of the pus.

B: involvement of lymph nodes of the head: the retropharyngeal and submandibular lymph node.

C: involvement of the lymph nodes of the head: the parotid and submandibular. The hair over the parotid lymph node was shaved for sampling.

Figure 2

Appearance of abscesses among 1765 Hamari and 4400 Zaghawi sheep ecotypes followed up during fattening period of 20 days